



MAX PLANCK UCL CENTRE  
COMP2PSYCH  
International Max Planck Research School

Symposium and Advanced Course on Computational Psychiatry and Ageing Research

International Max Planck Research School COMP2PSYCH

# Cross-modal signatures of dynamic attention allocation across the adult lifespan

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Example: Navigating complex environments requires dynamic attention routing





# The thalamus as a “switchboard” for cortical information

- Modulation of **global brain networks**

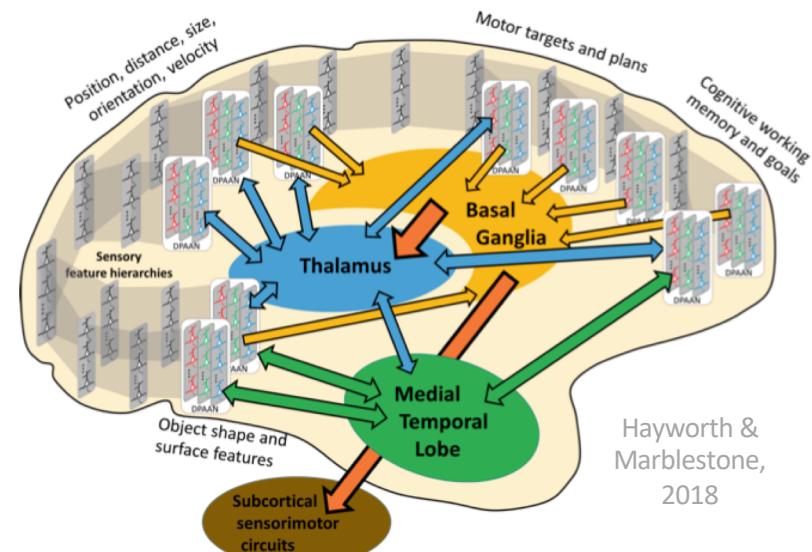
(e.g. Garrett et al., 2017; Cunningham et al., 2017; Ketz et al., 2015; Hwang et al., 2017)

- Causal role in higher-order cognition**

- Attentional selection (Saalmann et al., 2012; Schmitt et al., 2017)
- Working memory (Bolkan et al., 2017; Parnaudeau et al., 2013)
- Cognitive flexibility (Ouhaz et al., in prep.)
- Goal-directed navigation (Ito et al., 2015)
- Rapid reward updating (Chakraborty et al., 2016)

- Morphological **differences across the lifespan**

(Hughes et al., 2012; Van der Werf et al., 2001; Fama & Sullivan, 2015)



Hayworth &  
Marblestone,  
2018

Cortico-cortical pathways  
(supervised and statistical learning)

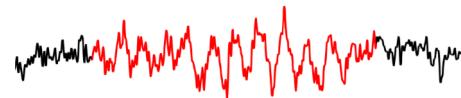
Cortico-thalamo-cortical pathways  
(routing, latching, copying)

*“The thalamus forms a functional backbone that sustains, coordinates and switches distributed cortical computations.”*

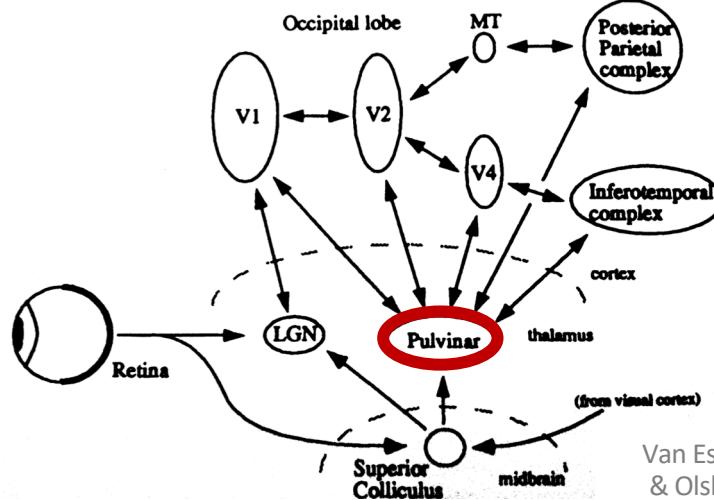
(Schmitt et al., 2017)



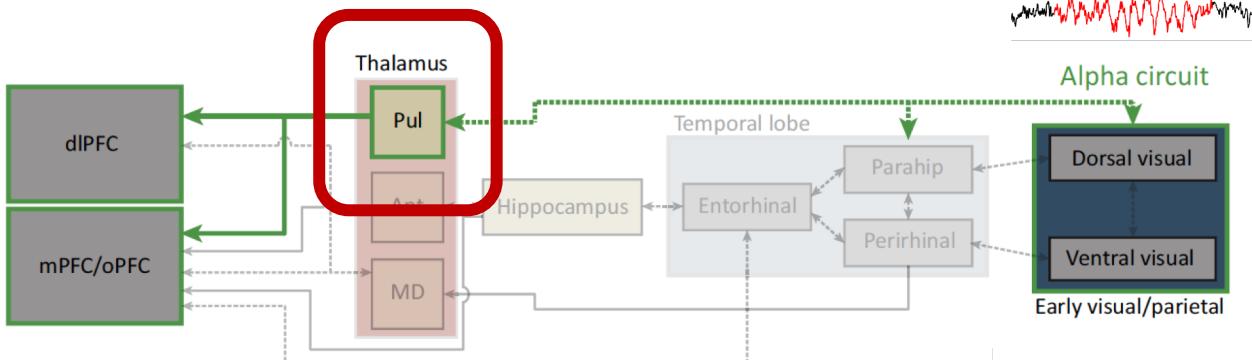
**Selective attention** is a major target of investigations into the role of the higher-order thalamus



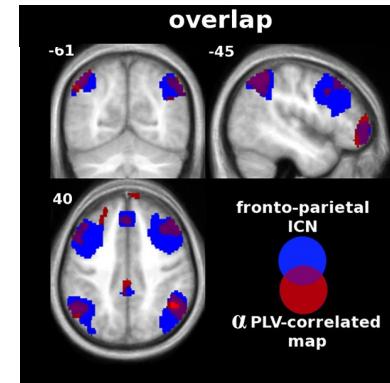
Thalamic activity links to rhythmic neural fields: cortical **alpha rhythms** (~8-12 Hz) as a mechanism for top-down cognitive control



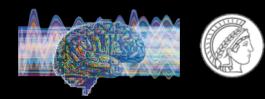
Van Essen, Anderson & Olshausen (1994)



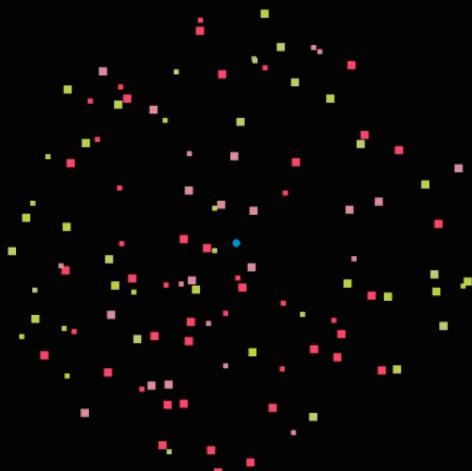
Ketz et al. (2015)



Sadaghiani et al. (2012)



# State Switch



Multi-attribute 'dot' clouds with four attributes:

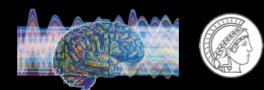


- Parallel EEG-fMRI sessions with 49 young and 53 older adults
- Dynamic switching of feature-selective attention

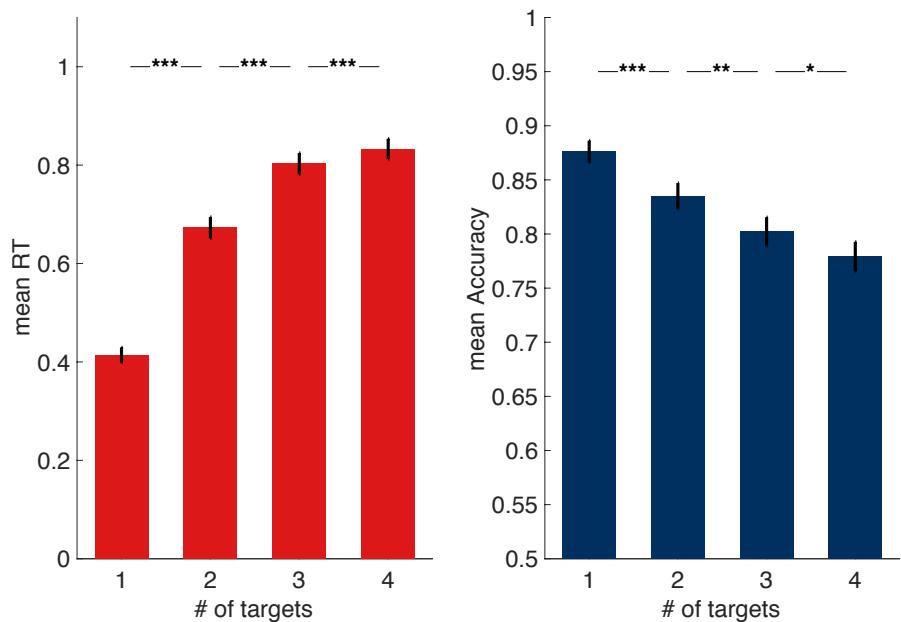


relevante Attribute: 3





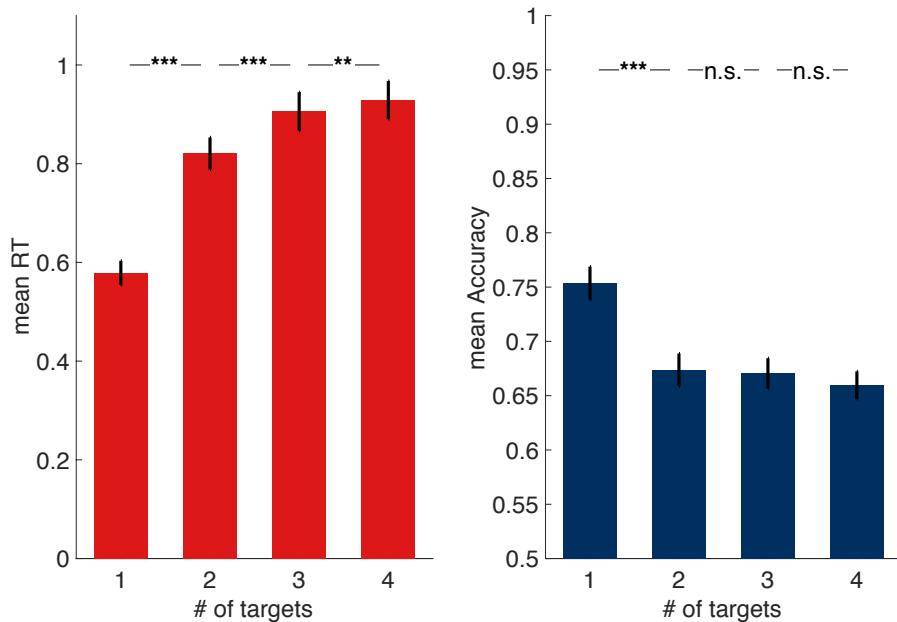
## Younger adults



General **RT** pattern:  
response slowing

General **accuracy** pattern:  
accuracy decreases

## Older adults



**Individual**  
Slope       $R = .69$   
Reliability

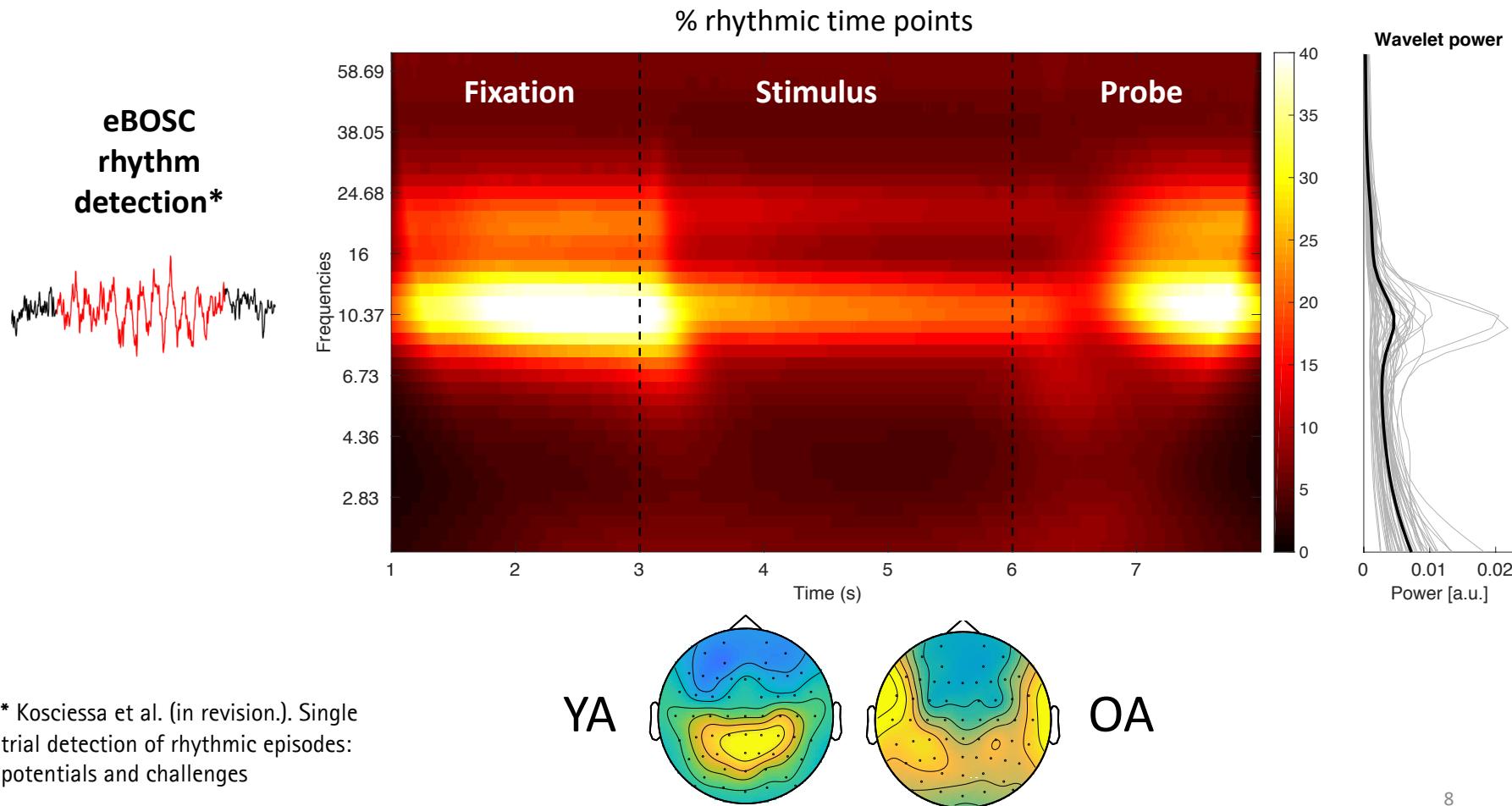
$R = .56$

$R = .50$

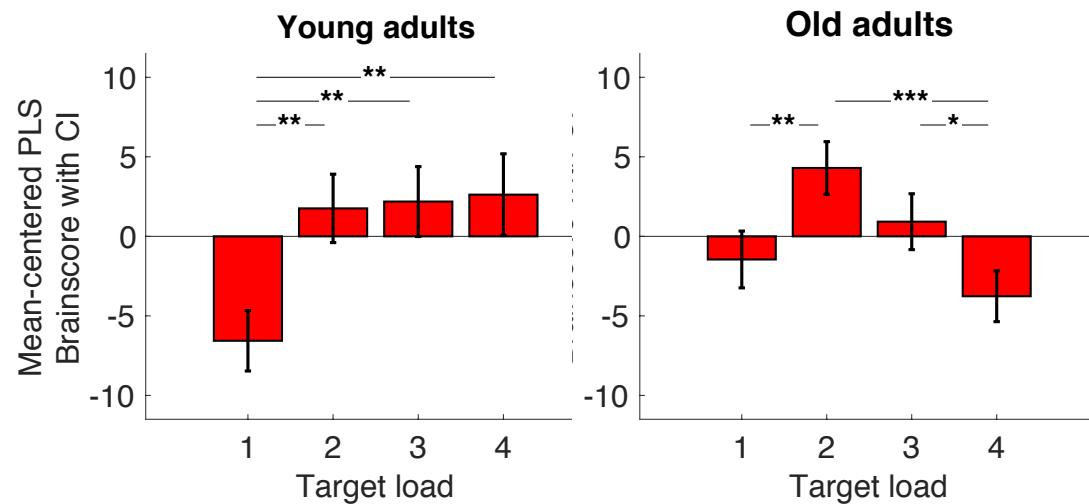
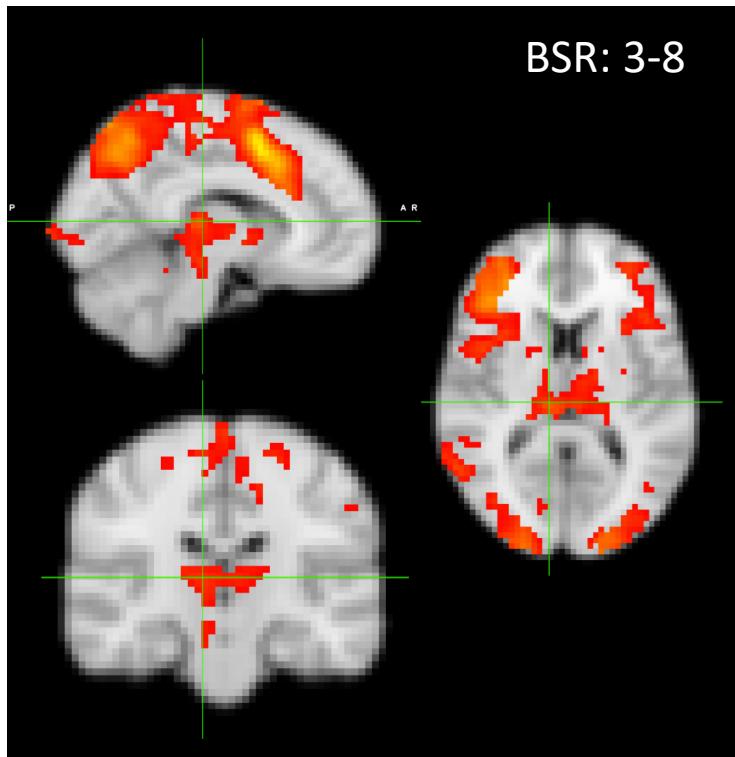
$R = -.15$



## Alpha rhythms are prevalent throughout the task, despite 'desynchronization'

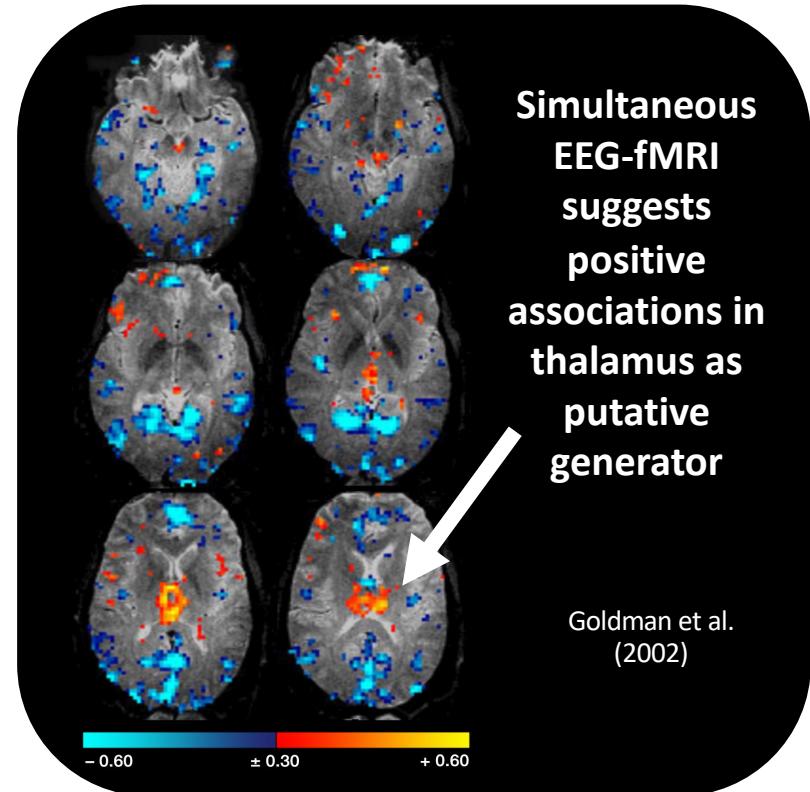
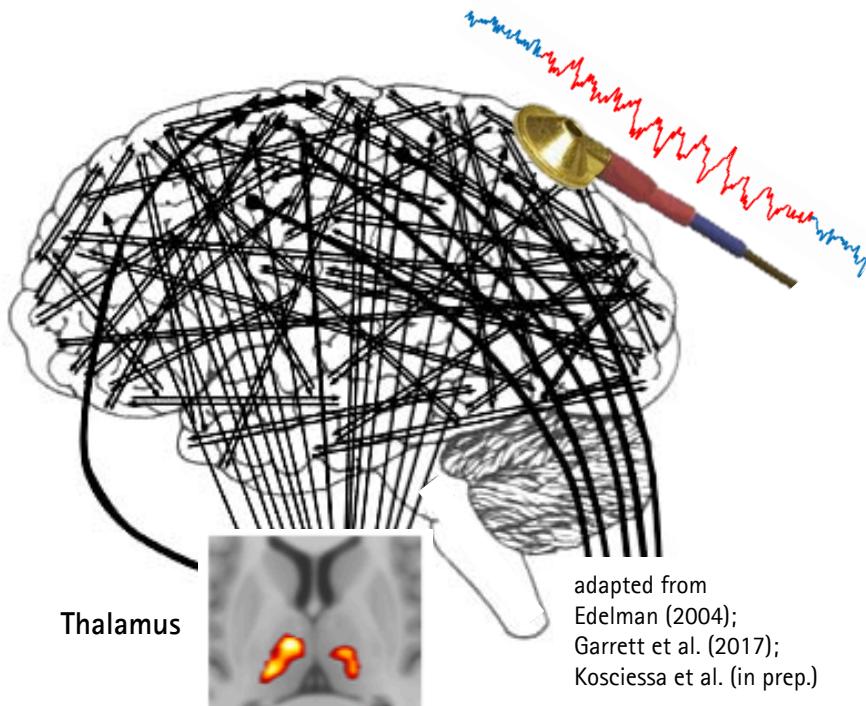


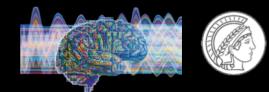
## Mean BOLD in frontoparietal network increases when attention is shifted



Older adults show a drop at higher target loads

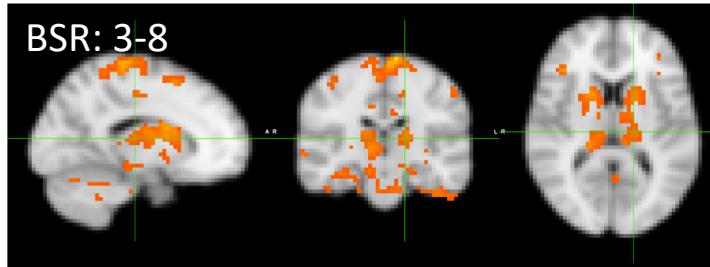
## Concept: Thalamic dynamics relate to alpha-band rhythmicity



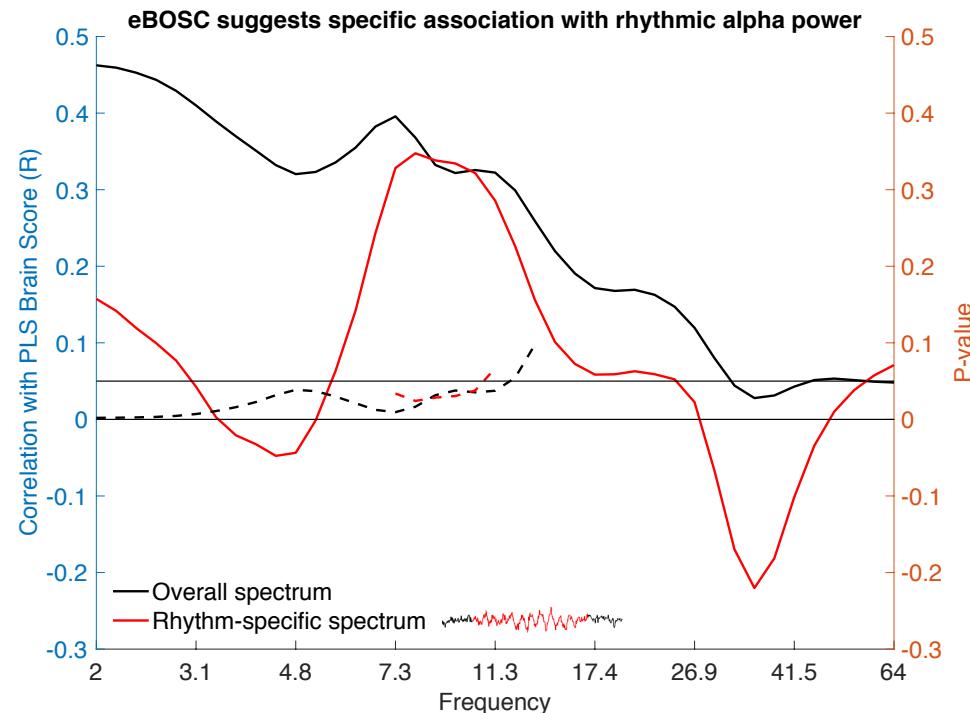
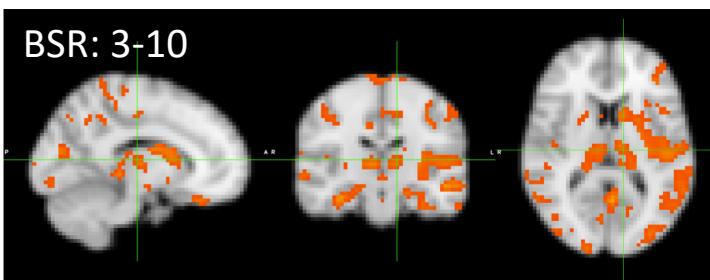


## Multivariate PLS suggests links between thalamic BOLD variability and alpha rhythms during rest and task

**TASK: Total EEG Power ( $r = .47$  with GFP)**



**REST: Total EEG Power ( $r = .53$  with GFP)**



# Summary

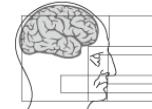
- Dynamic attention allocation incurs reliable behavioural costs across the adult lifespan.
- Thalamocortical activity may underlie attentional switching, with impaired expression at high switching loads in older age.
- Thalamic rhythmogenesis may account for EEG-BOLD power coupling.



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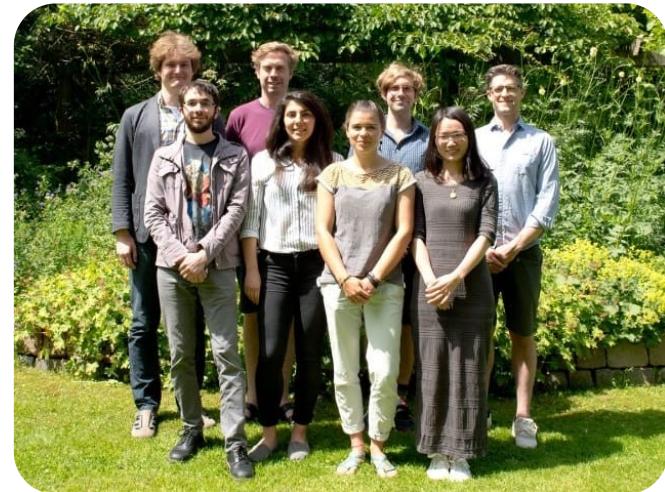


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# Thank you!



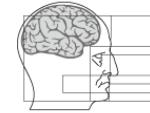
+ special thanks to everybody involved in data contribution, collection and management



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# Q&A

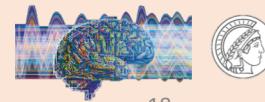
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